AD-775 478

XM129 40mm GRENADE LAUNCHER BARREL IMPROVEMENT PROGRAM

Maremont Corporation

Prepared for:

Army Armament Command

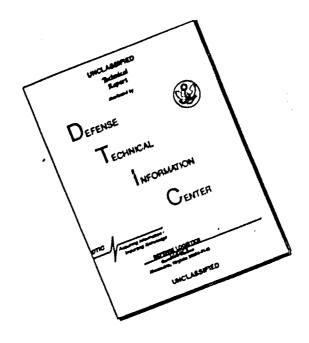
22 February 1974

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# AD775478

Final Technical Report

XM129 40mm

Grenade Launcher

Barrel Improvement Program

Contract No. DAAF03-73-C-0140



Commanding General U.S. Army Armament Command Rock Island, Illinois 61201

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#### INTRODUCTION AND SUMMARY

Various materials, coatings and mechanical changes to improve barrel life were previously tested and evaluated by Maremont under contract DAAF03-71-C-0331. It was concluded by that effort that one of the materials tested, H-II tool steel, showed promise of significantly extending the average service life of the XM129 40mm barrel and it was recommended that additional testing be accomplished.

The objective of the scope of work under Contract DAAF03-73-C-0140 was to fabricate one (1) hard chrome plated H-11 alloy barrel and test fire it a total of 15,000 rounds or until the barrel was declared unserviceable. In addition, test firing of barrel #H-1 of H-11 material from the previous contract would continue until 15,000 rounds or it became unserviceable. Barrel #H-1 was initially fired 9,359 rounds at which time an in-bore jam occurred when the projectile, during chambering wedged against a piece of rotating band which had been torn loose from the previous round and lodged in the barrel.

The test firing was to be conducted in accordance with the schedule approved for the first contract. This work has been completed, the barrels have been sectioned and examined and the findings are presented in this report.

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#### CONCLUSIONS

The observations made during the metallographic examinations showed that the erosion rate of the chrome plate and the substrate material was much slower in barrels with the H-11 alloy material than with the standard barrel of AISI 4340. The hard chrome plate does not crack and pop off the H-11 alloy as was characteristic with the AISI 4340 and once exposed, the H-11 exhibits a much greater resistance to the erosion action of the hot gas stream.

These factors indicate that the average service life of the XM129 40mm barrel can be significantly increased with the use of H-11 material. Based on the performance of the various barrels tested ner the prescribed firing schedule, the H-11 material with a hard chrome plate bore would nearly double the average service life of this barrel.

#### RECOMMENDATIONS

The following recommendations for increasing the average service life of the XM129 40mm barrel are based on the performance characteristics of those barrels tested under Contract DAAF03-71-C-0331 and the current contract and an in-depth engineering evaluation.

- 1. Redesign of the cartridge case so the high velocity gases do not impinge directly on the sides of the barrel.
- 2. Applications of thicker chrome plate on the barrel bore.
- 3. Use of H-11 alloy steel as the barrel material. H-23 alloy steel would be an alternate if the proper heat treatment can be maintained to avoid brittle failures.

#### DISCUSSION

Barrel #H-1 was fired a total of 9,359 rounds during the initial test program and was declared unserviceable at that time when an in-bore jam occurred. During the current contract effort, an additional 2,828 rounds were fired for a total count of 12,187 rounds on the barrel. Two in-bore jams were experienced, the first after 1,580 additional rounds and the second after another 1,248 rounds.

There was no visible signs of damage to the barrel because of the in-bore jams after 9,359 and 10,939 rounds but there was evidence after the third in-bore jam after 12,187 rounds. The barrel was, therefore, declared unserviceable. Examination of the barrel bore surface showed a series of ripples/wrinkles beginning about 8 inches from the breech end and continuing to within 2 inches of the muzzle end. The air gages would no longer pass through the barrel indicating significant distortion had occurred. Measurements of the OD indicated the barrel was out of round with the maximum diameter located across the distorted area. The minimum diameter was 1.792 and the maximum diameter was 1.811 in the same plane.

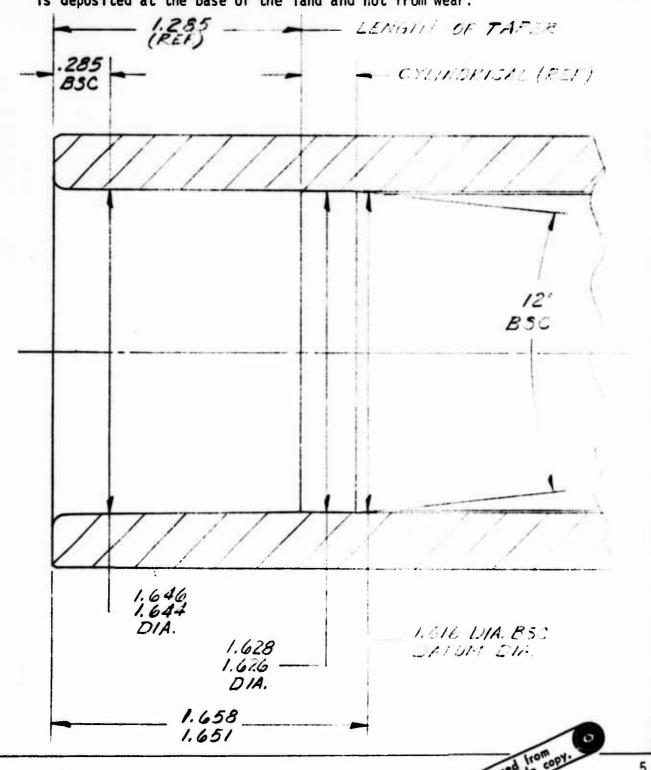
It was observed that the out of roundness and wrinkles followed the twist of the rifling. The conclusion was made that a piece of rotating band tore loose from a projectile and remained in the barrel. When the next round was fired, the projectile carried the piece of band forward until it became wedged in the bore. The momentum was sufficient enough to launch the projectile but tended to swage and distort the barrel under the circumstances. Because of this damage and the fact that a third in-bore jam occurred, firing of this barrel was terminated.

Figures 1 and 2 shows the erosion pattern on barrel #H-1 at the origin of rifling and along both sides of the rifling.

It appears that the chrome plating tends to wear/erode away initially at a step in the chamber at the intersection of the 1.626 diameter and the 12° included angle taper at the origin of rifling. The sketch below shows a section through the chamber. After the chrome flakes away, the base material is prone to erosion and a relatively sharp edge is formed. See Figure 4. As the projectile moves down the bore, the rotating band tends to catch on this edge and be torn apart occassionally leaving a portion in the bore.

Figures 3 through 7 are magnified views of various areas along the bore surface of barrel "H-1. Figure 3 shows the surface just aft of the erosion groove shown in Figure 4. Cracks in the chrome plate extend into the base metal and erosion eventually undercuts the chrome until it flakes off thus exposing the base material. The erosion groove shown is approximately .015" deep and .035" wide.

Figure 5 shows the bore condition just forward of the erosion groove. The areas shown in Figures 6 and 7 are from sections of the rifling groove adjacent to a land showing a difference in chrome thickness. This difference is believed to be a resultant of the plating process whereby a thinner layer is deposited at the base of the land and not from wear.



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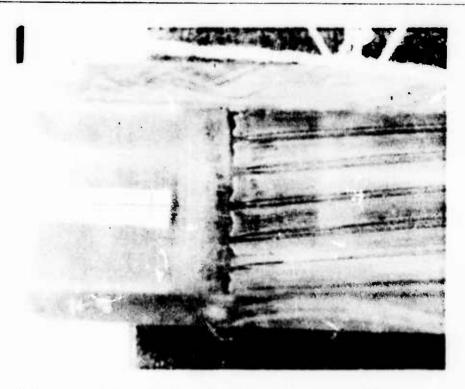


Figure 1. View of Bore Erosion on Barrel #H-1.

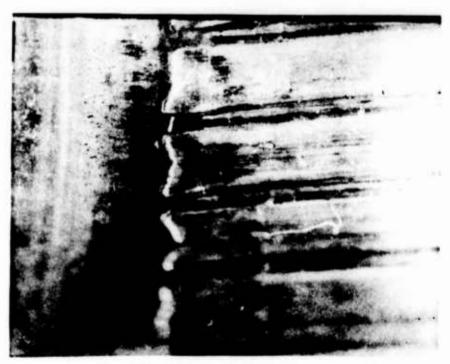


Figure 2. Magnified View of Bore Erosion on Barrel #H-1.



Figure 3. Longitudinal Section of Barrel #H-1 Showing Bore Surface 1 19/32" from Breech End.



Figure 4. Longitudinal Section of Barrel #H-1 Showing Bore Surface In the Erosion Cavity 1 11/16" From Breech End.



Breech End 100X

Figure 5. Longitudinal Section of Barrel #H-1 Showing Bore Surface 1 25/32" From Breech End.

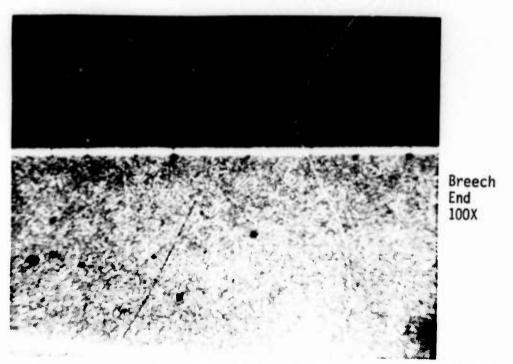
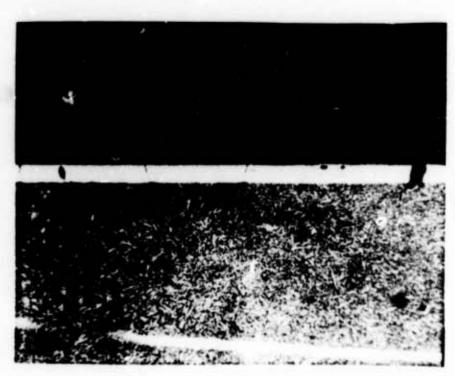


Figure 6. Longitudinal Section of Barrel #H-1 Showing Bore Surface 2 1/2" From Breech End.



Breech End 100X

Figure 7. Longitudinal Section of Barrel #H-1 Showing Bore Surface 3 13/32" From Breech End.

Barrel #H-3 was fired a total of 15,000 rounds without a malfunction. Examination of the bore at the origin of rifling, Figures 8 and 9, after firing was completed showed the erosion was not as severe in this barrel as in #H-1 and significantly less than on #H-2. The wear/erosion was not uniform around the circumference with very little erosion over approximately  $\frac{1}{4}$  of the distance as can be seen in Figure 9.

Appendix I contains the measurement records for the three H-11 alloy barrels and two of the standard barrels. Comparing data shows the rate of wear of the H-11 barrels on the average was much less than those of standard material and #H-3 much slower than the others. In general, the distance to the origin of rifling is the best indicator of barrel degradation for example; #H-3 was .034 over maximum after 15,000 rounds, #H-1 was .048 over at 10,939 rounds and #H-2 was .039 over at 4,500 rounds. The standard barrels exhibited .035 and .063 over maximum after 3,000 rounds were fired.

Figures 10 through 14 are magnified views of various areas along the bore surface of barrel #H-3. The condition of the chrome plating and the base material is quite similar on all the H-11 alloy barrels. Propellant gases tend to attack the base metal through the cracks in the chrome plate but not as severely as with the AISI 4340 alloy barrels. The cracks do not have a tendency to propagate after the chrome plate has eroded away. Effective life of the barrel appears to have been extended because of a greater bond characteristic of the chrome plate with the H-11 alloy substrate.



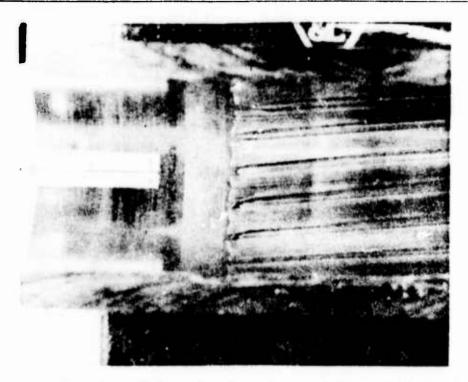


Figure 8. View of Bore Erosion of Barre! #H-3 Half Section #1.

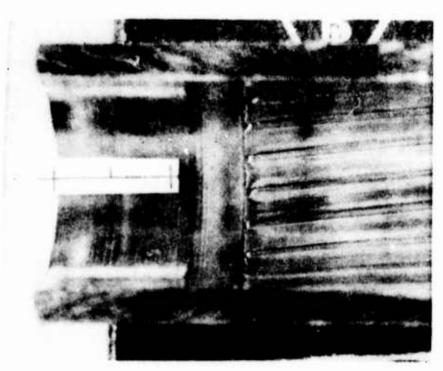


Figure 9. View of Bore Erosion of Barrel #H-3 Half Section #2.



Figure 10. Longitudinal Section of Barrel #H-3 Showing Bore Surface 1 5/8" From Breech End.



Figure 11. Longitudinal Section of Barrel #H-3 Showing Bore Surface In the Erosion Cavity 1 1/16" From Breech End.



Figure 12. Longitudinal Section of Barrel #H-3 Showing Bore Surface 1 3/4" From Breech End.



End 100X

Figure 13. Longitudinal Section of Barrel #H-3 Showing Bore Surface 2 1/2" From Breech End.



Figure 14. Longitudinal Section of Barrel #H-3 Showing Bore Surface 3 7/16" From Breech End.

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APPENDIX I

#### FIRING SCHEDULE

The firing, cleaning and inspection schedule for each barrel was as follows:

- a. 100 round burst followed by a 3 minute cooling.
- b. 3 25 round bursts with 1 minute cooling between bursts.
- c. 50 round burst followed by a 2 minute cooling.
- d. 3 25 round bursts with 1 minute cooling between bursts.
- e. 50 round burst followed by a 2 minute cooling.
- f. 2 25 round bursts with a 1 minute cooling between bursts.
- g. 50 round burst followed by a 2 minute cooling.
- h. 3 25 round bursts with a 1 minute cooling between bursts.
- i. 50 round burst followed by a 2 minute cooling.
- j. 2 25 round bursts with a 1 minute cooling between bursts.
- k. 100 round burst followed by a 3 minute cooling.
- 1. 25 round burst for accuracy check.
- m. Clean after 750 rounds and clean/inspect after 1.500 rounds.

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Firing Test Record

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Date Tested 1/9/74
Barrel No H 1

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Clean after 750 rounds.

Inspect after 1500 rounds.

Romarks: "SHEARING Motor Drive PIN

new england group **MAREMONT** 

XM129 Barrel Improvement Program

Firing Test Record

Contract No. DAAFO3-71-C-0331

Date Tested 1/10/74 Barrel No #-

				R	OUNDS	FIRED		. 4			
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
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Clean after 750 rounds.

Inspect after 1500 rounds.

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Firing Test Record

Contract No. DAAF03-71-0-0331

Date Tested // 29/74

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25	V	V	Sal	nmed	On	vd:	1.3				
25	V					C PAC					
50	1										Y
25	1										
25	1	,									
100	1										er te,
. 0	1	1									

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks: Accepted Bond at 1248 135
Total rds on Barrel 12,187

ノラでコトリン

Firing Test Record

Contract No. DAAF03-71-C-0331

Date Tested ///5/77
Barrel No #3

				RO	UNID3	FIRED					117-27
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
SER.	750	1509	2250	3000m	3750	1500	5250	6000	6750	7500	8250
100		V									
25		W									
25	1	V									
25	1										
50	1	V									
25.	V										
. 25 .	V										
25	1										
50	1	V									
25	V		/								
25	V	V									
50	U	V									
25	1										
25	V	V									
25	V.	1									
50	V										
25	V	U									
25	V	V									
100	1	1									
①	V										

Clean after 750 rounds.

Inspect after 1500 rounds.

Romarkos BAD CHUTE LINKAGE

2010 KDS

XM129 Barrel Improvement Program

Firing Test Record

Contract No. DAAF03-71-C-0331

Date Tested ///7/74

Barrel No H 3

					R	OUNDS.	FIRED		· · · · · · · · · · · · · · · · · · ·			
	TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
	SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	8250
50	100	V										•
	25	V	,									
	25	V										
	25	V.										
	50	V										
	25	1	1									
	. 25	V										
	25	1										
	50	1	1									
	25	V.	1									
	25	V										
	50	1	V									
_	25	1										
	25											
-	25	V										
	50	-	V									
	25	V										
	25	1	1									
50	. 100		V		L							
114	·· ①	1	1									

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks:"^

MAROMONT

					િ	ouws	FIRED					
	TEST	0	750	1500		-	3750	4500	52501	6000	6750	7500
	SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	8250
50	100	V	V	,								
	25	V										
	25	1										
	25	V	1					7				
	50	V	V.									
	25	1	1									
	25	1	V									
	25	1										
	50	1										
11	25	V										
	25	V	V									
	50	V										
j	25	V	V	,								
	25	V	1									
	25	V	1									
	50	V	V									
	25	V										
	25	V	1									
و و	100	V	1									
	. 0	V										

Clean after 750 rounds.

Inspect after 1500 rounds.

REMARKS: REPAIRED IN PART PLATE 1/01/24 - 1/04/74
-RESUMED FIRING 1/04/74

new england group MAREMONT CORPORATION

XM129 Barrel Improvement Program

Firing lest Record

Contract No. DAAF03-71-C-0331

Date Tested 1/26/74 Barrel No

			D20	13	CUMD3	FIRED					
TEST	0	750	1500	2250	<b>300</b> 0	3750	4500	5250	6000	6750	750
SER.	750	1500	2250	3000	n <b>37</b> 50	1,500	5250	6000	6750	7500	825
100											
25	V										
25											
25	V	-									
50											
25		1									
25	1	1									
25	1	V									
50	V	V									
25	V	1									
25	V	V									
50	1	1									
. 25		V									
25	-	V									
25	1	V									
50	V	V									
25.	V	V,						-			
25	V	1									
100	0			L							
0	1										

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks

...

10869 11 200

Firing Test Record

Contract No. DAAF03-71-0-0331

Date Tested 2/5/14

Barrel No # 3

				Fi.	OUNDS	FIRED					
TEST	0	750			1	3750		4	1	6750	750
SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	825
100	1	V									
25	1										
25	-										
25	U	V									
50	V	6									
25	1										
. 25		V									
25	1										
50	1	1									
25	1	V									
25	1	V									
50	1	V	/								
25	0	V									
25		·V									
25	V	1									
50	U	V									
25	V	V									
25	V	·U									
100	V	V	,								
·· ①											

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks: "CIENT BLUS BROKEN FIRINGPIN NEFDS NEW SPYING + CAM GENIZ

CORPORATION

XM129 Barrel Improvement Program

Firing Test Record

Contract No. DAAF03-71-0-0331

Date Tested 2/7/74 Barrel No H 3

				15	COMOS	FIRED					
TEST	0	750	1500	2250	3000	3750	4500	52501	6000	6750	7500
SER.	750	1500	2250	3000	n <b>37</b> 50	4500	5250	6000	6750	7500	8250
100	V										
25											
25	1				Anne						
25	1	V.									
50	1	V									
25		V									
25	1										
25		1	,								
50	1	V									
25		V		-							
25	V	1									
50		V									
25		V									-
25	-	V.									
25		V:									
50		1									
25	-	U	,								
25	0										
100	V,	V									
. 0	1	V					j.				

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks:"~

Firing Test Record

Contract No. DAAF03-71-0-0331

Date Tested 3/11/74

Barrel No H-3

				R	omnos	FIRED					
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	825
100	V	1									
25	V	V									
25	0										
25	1	V									
50	1	1									
25		V									
25	V	V									
25	1	1									
50	1	V									
25	1	1									
25	1	V									
50	1										
25	V										
25	1	1								1000	
25	/	V									
50	V										
25	V	1									
25	7		/								
100	V										
. 0	1	V									

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks:

Firing Test Record

Contract No. DAAFO3-71-C-0331

Date Tested 2/13/14

Barrel No H 3

e. -		-									
			,		COMIO						
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
SER.	750	1500	2250	3000	n <b>37</b> 50	4500	5250	6000	6750	7500	8250
100	V	1									
25	V	1									
25											
25	/	V									
50		V									
25	1	-									
25	1	V									
25	1	V									
50		V									
25		1									
25		0									
50	1	V									
. 52	1										
25											
25	1	V.									
50		1									
25	V	V									
25	4	W									
100	~	-									
·· •	-										

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks: "~

Firing Test Record

Contract No. DAAF03-71-C-0331

Date Tested = 16 74

Barrel No H =

		_		R	OUNDS	CASIT					
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	8250
100	V										
25	V	~									
25	1	0									
25	1	U									
50	1	1									
25	1										
25	1	-									
25	1	V									
50	1	1									
25	V	-									
25	1	V									
50	V										
. 25	V	1									
25	1										
25	~	V									
50		~									
25	1	V									
25	0	1									
100	V	-									
•	1	/									

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks:"

13,500RD'S

Firing Test Record

Contract No. DAAF03-71-C-0331

Date Tested 19174

Barrel No 43

				R	OUNDS	FIRED		· · · · · · · · · · · · · · · · · · ·			
TEST	0	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
SER.	750	1500	2250	3000	3750	4500	5250	6000	6750	7500	825
100	1	1									
25		0									
25	1										
25	1	1									
50	1	1									
25	V										
. 25	V	V									
25	V	V									
50	V	V									
25	V	0									
25	1	1									
50	0	1									
. 25	1	V									
25	V	V									
25	V	1									
50	V	1									
25	V	1									
25	V	1									
100	1	V									1
· (0)	V	V									

Clean after 750 rounds.

Inspect after 1500 rounds.

Remarks:" 15,000 RDS COMP.